Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period:\_\_\_\_\_\_\_

**LAB - Floating Spinach Disks: Measuring the rate of photosynthesis**

**Problem**: How do different light sources affect the rate of photosynthesis?

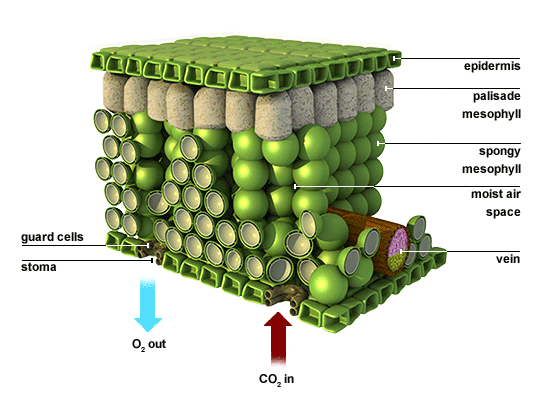
**Background**: Photosynthesis converts energy absorbed from sunlight into chemical energy of sugars. Although numerous intermediary reactions (light-dependent and light-independent reactions) are involved, the overall photosynthetic reaction is simple:

**Light (energy)**

**6 H2O + 6 CO2 C6H12O6 (energy)+ 6 O2**

Normally the spongy mesophyll layer of leaves is infused with gases (O2 and CO2), and so leaves float in water. However if the gases are removed then the leaves will sink. A syringe will be used to create a vacuum which will remove the gases and allow for a sodium bicarbonate solution to enter. The entrance of sodium bicarbonate solution into the leaf increases the density so the leaf disks will sink.

Sodium bicarbonate (NaHCO3), commonly known as baking soda, will be used as a source of carbon dioxide (CO2). Detergent will be used to break down the hydrophobic surface of the leaf so that gases can diffuse in and out of the leaf.



As photosynthesis occurs oxygen gas (O2) is produced which decreases the density of the leaves and causes the leaf disks to float. Measuring the rate at which leaves float by counting the number of leaf disks that are floating each minute for 15 minutes is an indirect measure of the rate of photosynthesis.

**Pre-lab questions:**

1. What is the source of CO2? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the purpose of the detergent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What is the purpose of the syringe creating a vacuum?
4. The type of light is the…(choose one) *Independent variable? Dependent variable? Control?*
5. The number of disks floating is the……(choose one) *Independent variable? Dependent variable? Control?*
6. The disks to which CO2 is NOT added are ……*Independent variable? Dependent variable? Control?*

What specific types of lights will you be testing? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

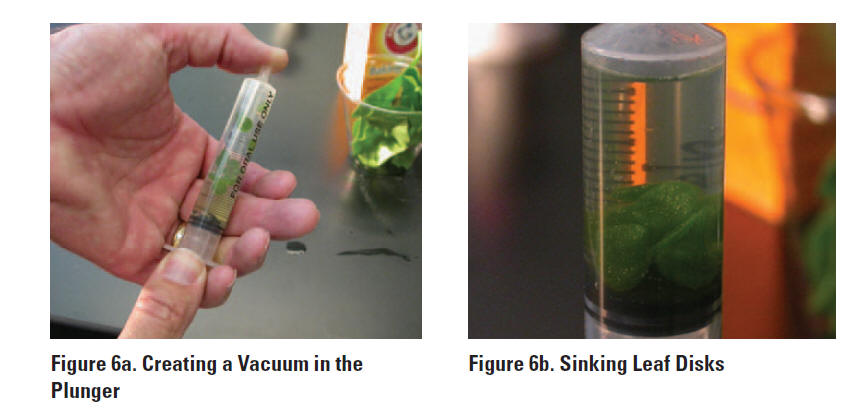
**Hypothesis:**

If the spinach disks are put under \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ light then photosynthesis will occur the fastest because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Materials:**

* Spinach leaves
* (optional) petri dish to store leaf disks
* Straws
* Sodium bicarbonate (baking soda)/detergent solution
* Water/detergent solution
* Two labeled cups: one for leaves with CO2, one for leaves without CO2 (the control)
* Two plastic 10-cc siringes
* Different light sources
* Timer

**Procedure:**

1. Use a straw to punch out 20 spinach leaf disks (10 for with CO2, 10 for without CO2). Can temporarily store on a petri dish.
2. Remove the plunger from each syringe and place 10 spinach leaf disks in each syringe.
3. Insert the plungers back into the syringe.
4. In one syringe draw about 5 cc (5 mL) of the sodium biocarbonate/detergent solution. This is the liquid in the cup labeled “with CO2” (yellow)
5. In the other syringe draw about 5 cc (5 mL) of the water/detergent solution. This is the liquid in the cup labeled “without CO2” (green)
6. Hold each syringe tip upward and push the plunger up to remove air. Tap each syringe to ensure the leaves are in the solution and there are no air bubbles.
7. Keeping the each syringe inverted place your finger over the tip of the syringe. Withdraw the plunger until it reaches around 10 cc (10 mL). This creates a vacuum. Gently swirl/shake the syringe while maintaining the vacuum for at least 10 seconds. The gases in the air spaces in the leaf disks move into the syringe and the solution diffuses into the air spaces.
8. Take your finger off the tip of the syringe. The plunger should spring back. If not a good vacuum was not created and you should repeat steps 6 and 7. The leaf disks should have sunk to the bottom of the syringe because they became more dense from the diffusion of solution into the air spaces. If all the leaf disks did not sink repeat steps 6-7. If after three tries the disks still do not float there is probably not enough soap in the solution. Ask teacher for assistance.
9. Open each syringe by pulling the plunger and pouring the leaf disks and solutions into their respective cups.
10. Record the number of disks floating in each cup. There should be none (“0”).
11. Have a timer ready. Put both cups with leaf disks under the same type of light and begin timing. Every minute record the number of leaf disks.
12. Repeat the procedure twice with two other types of light.

**Data**:

Table 1: Effect of different types of light on the rate of photosynthesis

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Type of light: | | Type of light: | | Type of light: | |
|  | # of floating disks | | # of floating disks | | # of floating disks | |
| Time (min) | With CO2 | Without CO2 (control) | With CO2 | Without CO2 (control) | With CO2 | Without CO2 (control) |
| 0 |  |  |  |  |  |  |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  | ` |  | ` |  | ` |
| 4 |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |
| 6 |  |  |  |  |  |  |
| 7 |  |  |  |  |  |  |
| 8 |  |  |  |  |  |  |
| 9 |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |
| 11 |  |  |  |  |  |  |
| 12 |  |  |  |  |  |  |
| 13 |  |  |  |  |  |  |
| 14 |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |

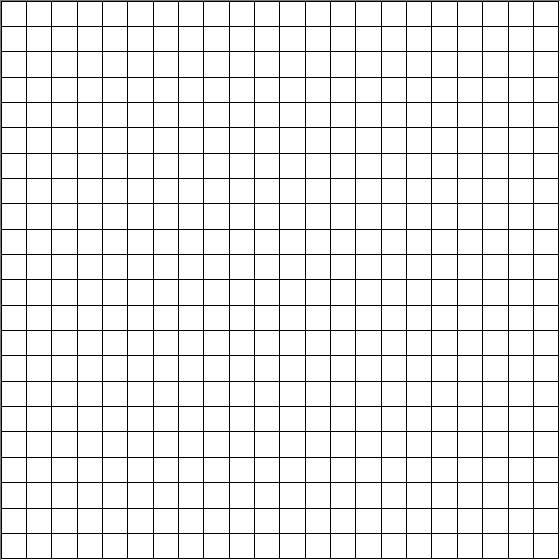
**Analysis**:

1. Under which condition(s) did the disks float the fastest?
2. Under which condition(s) did the disks float the slowest?
3. Summarize the results. (Ex. All the disks with CO2 under blue light floated within 8 seconds….)

Using different colors for each type of light, graph the data. Create a legend (Ex. Yellow light = yellow (marker)).

Legend

Graph 1: Effect of different types of light on the rate of photosynthesis



# of floating disks

Time (min)

**Conclusion:**

1. Does the data support your hypothesis? Explain.
2. Based on the data, in what type of light does photosynthesis occur the fastest?
3. Based on the data, in what type of light does photosynthesis occur the slowest?
4. Identify possible reasons for inconsistent results.